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Improving Internet use by people with disabilities

Windows to the World: A Gateway to the Internet for Visually Impaired Users

1 Project Purpose

A Specific need or problem

To paraphrase Samuel Johnson, information today is of two kinds: it is online, or someone who knows it is online. Yet, people with disabilities are far less likely than those without disabilities to make use of the Internet [1]. The gap is striking: people without disabilities are four times more likely than people with disabilities to use the Internet (38.1 vs. 9.9 percent). Similar patterns remain even when such factors as income, gender and educational attainment are taken into account [2]. The large gap in Internet usage can be attributed in large part to problems with accessibility. A recent study by the Nielsen & Norman Group found that usability of the Web is about three times better for users without disabilities than it is for users with disabilities [3].

Currently, all Federal and Federally-financed entities are legally required to make their websites accessible to people with disabilities [4], leaving business and non-profit organizations that do not receive Federal funding free from such binding. However, it is these non-regulated websites that comprise the majority of the 1000 websites which are most visited, and, despite the existence of guidelines and tools for developing accessible websites, the majority of these sites remain inaccessible. One explanatory factor for the lack of progress toward accessibility is that website developers assume that access adaptations result in bland and unattractive content formatting. Furthermore, designing or redesigning websites to meet accessibility requirements is quite costly; according to *BtoB Magazine*, the median price in 2001 for a small website development project was \$65,000 and for a large website, \$250,000 [5]. According to our own recent testing, none of the 25 most visited sites as determined by Nielsen Ratings [6] meet accessibility requirements.

Opening the door for people with disabilities to greater access to the Internet will offer them the exciting possibilities promised by e-commerce and the new economy. The Internet can serve as a tool to assist people with disabilities in community participation by overcoming environmental barriers. Importantly, it can help with procuring and maintaining employment despite functional limitations [7]. In addition, the Internet permits people with disabilities to more easily find medical information, social services and educational programs. It is important to note that for people with disabilities, the web very often is the only source of information and knowledge to which they may have access without having to depend unduly on others. But, for computers and the Internet to be of real use to people with disabilities, they must be accessible.

It is people with visual impairments, numbering about 10 million in the United States [8], who face the most serious barriers with inaccessible websites [9]. Jacob Nielsen has observed, "The most serious accessibility problems given the current state of the web probably relate to blind users and users with other visual disabilities since most Web pages are highly visual." [10]. Traditional website formats often are not appropriate for browsers designed for people with visual impairments. The proposed project will offer users with visual impairment a new possibility to attain Internet access.

Proposed Solution

This project will offer a gateway server to people with visual impairments that will be able to deliver them any website, whatever its level of accessibility (see Appendix II for illustration). The gateway will transform the content of any website into the most accessible

format for any user. Ultimately, dissemination of the gateway will be targeted toward portal sites like Google or Yahoo that depend upon advertising for the accrual of profits, or as part of an ISP service such as AOL that, besides advertising, will accept cost in order to realize profit from new subscribers. Thus, the gateway will not incur cost to the user population or to website destinations. The solution that we propose in this project for delivery of accessible service is similar to that currently provided by Google that makes websites accessible to PDA users (Palm or Pocket PC).

A “window to the world,” the gateway will promote the accessibility of the Internet without requiring commercial websites to follow certain guidelines or standards for users with disabilities. This solution will break the barrier often encountered in leaving the responsibility for access to developers’ conformance with these guidelines. No expensive website redesigning will be required, and no expensive software purchase will be needed. The University of Pittsburgh will partner with the American Foundation for the Blind (AFB, a national organization) and a local service organization, the Pittsburgh Vision Center (PVS), to reach out to blind users and immediately offer them greater access to the many rewards of the Internet. PVS will actively support and train its clientele with vision impairments on using the gateway. AFB will conduct rigorous evaluation (usability studies), will assist with enhancement of the technology for application to blind users, and will disseminate the gateway to its many local social service affiliates. The gateway will be linked to the websites of both partners.

This gateway can easily be extended to benefit people with other types of disabilities, such as dyslexic and scotopically-sensitive users. In fact, we aim to develop an “*electronic curb cut*” [11] that will eventually make the Web accessible to people with different disabilities and to people without disabilities in a variety of contexts, including mobile phone and palmtop usage. One lesson learned from the curb cuts that make sidewalk curbs accessible to the wheelchair user is that curb cuts are useful to a variety of people with and without disabilities to accomplish a range of tasks, such as pushing baby carriages or hand trolleys.

Expected Outcomes

This gateway server will affect the target population in many ways. First, the gateway will serve as a window to the world of the Internet for these users. Using this gateway, every website can become accessible, whether or not it was created by the developer to be accessible. Second, as accessibility increases, the productivity as well as the user satisfaction of visually impaired users will be expected to increase. Third, gateway usage training can be tailored for users with differing levels of computer skills. This project will work toward closing the digital divide between people with disabilities and the rest of the population. Therefore, measurable outcomes of the project include:

- (1) A significant increase in the accessibility of websites accessed via our gateway;
- (2) An increase the productivity of visually impaired users;
- (3) An increase in the user satisfaction of visually impaired users;
- (4) The development of a model for effective user service provision to users with differing computer skills;

The first three goals will be measured systematically through conducting rigorous usability studies that compare the success of accessing a website via the gateway and without the gateway. These studies will be conducted using established methods available in the scholarship and literature from the field of Human Factors. See Appendix III for the usability measures to be utilized in this project.

Goals	Measurements
Increase accessibility	Objective: Bobby Test Approval Subjective: Perception of visually impaired users.
Increase productivity	Efficiency and success in accomplishing tasks conducted over the Internet
Increase user satisfaction	Subjective assessment by users on important factors such as helpfulness, control, and ease of use.
Develop user support model	Assessment of quality of user support and services

Table 1. Goals and Measurements.

The fourth goal will be accomplished by assessing the quality of training both objectively and from the viewpoint of users. It is assumed that some users will have better computer skills than others, and thus training on software will have to be tailored to meet the needs of users at different levels. The experience of deploying the gateway service in this project will be used to estimate the cost of delivering similar services in the future, and an economic and sustainable model will be developed at the end of the project.

Target Underserved Communities

As many blind and visually impaired users as possible will benefit from this project. People with disabilities, including people with vision impairments, are a group in need of society's assistance and attention. People with disabilities are much more likely than people without disabilities to live in poverty with incomes of \$15,000 or less (29% versus 10%). While eight in ten working-age (18-64) people without disabilities are employed full or part-time, only three in ten people with disabilities are (81% versus 32%). More than two out of ten of people with disabilities fail to complete high school, compared to less than one out of ten people without disabilities [12].

2 Innovation

The proposed gateway project will constitute an innovative approach to reducing the digital divide between people with disabilities and the rest of the population. Existing approaches have centered on providing accessibility guidelines for website developers and utilization of assistive technologies, such as screen readers for blind users. As explained in the previous chapter, these methods still leave nearly all of the most visited websites inaccessible to visually impaired users. Our approach, which does not rely on the developer to change the website, could likely garner wide adoption by portal sites, ISPs, and industry. It may even open up the possibility of simpler requirements to make websites accessible. Instead of asking users with disabilities to adapt to inaccessible websites, this new approach, in effect, will provide an efficient method for websites to be adapted to the users' functional impairments. Further, the technology and concepts implemented in this project can eventually make the web accessible not only for people with disabilities, but also for people without disabilities in using palm computers and mobile phones (incapable of viewing graphics and complex webpage) or automobile drivers (benefiting from enhanced auditory access).

This project will offer an innovative gateway using state-of-the-art technologies, namely XML (the eXtensible Markup Language) and Java. These are arguably the two most important Internet technologies since the advent of the web. XML is capable of transforming contents created in any markup language, such as HTML or XML, into other formats to produce different

presentations. Java has been used in the development of the prototype gateway server since it fits nicely with XML and other Internet technologies. The capabilities of XML and Java have offered the unprecedented opportunity to develop this gateway server.

3 Diffusion Potential

This project has the potential to impact upon any individual or organization in any geographical area. Because the gateway can be accessed through Internet links, it will be able to be utilized not only by persons enrolled in, or affected by, our project, but also by any Internet user anywhere in the country, or anywhere in the world. Moreover, the gateway server itself can be disseminated readily to anyone or any entity wishing to replicate it, since the primary component of the gateway is software. It is expected that the gateway can be installed easily and managed by web administrators. In addition, a website will be created that will serve as a clearinghouse for all information related to this project. Materials that can be downloaded by interested parties from this site will include: a gateway manual, software modules, an installation guide, a how-to guide for setting up a similar service, results of the usability studies, and articles and other publications from this project.

The American Foundation of the Blind (AFB) will be instrumental in disseminating the availability of the gateway server to visually impaired users across the country. With regional offices in New York, Atlanta, Chicago, Dallas, San Francisco, and Washington D.C., as well as hundreds of local affiliated organizations, AFB will use its strength through publications, news releases, and networks to reach visually impaired users from coast to coast.

The extensive usability studies and evaluation to be conducted in this project will provide important information to both the Internet and disability communities about disability accessibility of the Internet. At minimum this project will be presented at two conferences: the American Society for Information Science and Technology (ASIST) annual conference, and the annual conference on Technology and Persons with Disabilities. In addition, the results of the usability studies and evaluation, as well as experience from the development and deployment of the gateway will be published in relevant journals. These journals include those published by AFB, AccessWorld (a journal of technology access news for persons who are blind or visually impaired) and the Journal of Visual Impairment & Blindness (the established journal of research and practice for providers of services to people with visual impairment).

4 Project Feasibility

Technical approach

The main technical triumph of this project is the development of a gateway server that can transform inaccessible contents of any website into a format that is easily accessible to blind users. In order to ensure feasibility, a prototype has already been constructed that contains all main components of the system. For a user, the gateway is a starting point; it is the default “home” website when the user opens a web browser. From this gateway, users can access any website on the Internet. The contents of the site are then transformed to a format that is accessible and matches the user preferences. The technical architecture of the server gateway is illustrated in Appendix II and consists of the following main components: a Java-based application server, a transcoding module for adaptive transformation based on a technology developed by IBM, transformation rules based on XSLT (eXtensible Stylesheet Language and Transformation), and a client detection module.

The use of Java and XML as basic components in the gateway answer needs for *interoperability* and *scalability*, as well as cost-effectiveness.

Interoperability: Java and XML are portable standard technologies able to be deployed in any operating system and any machine, ranging from a Windows-Intel environment to Linux and Apple Mac, from a Unix-based Sun workstation to a large mainframe to a supercomputer.

Scalability: The gateway server must also be scalable. Initially, we will deploy the server using a Windows-based mid-range server from Dell with 2 processors and 1 GB of RAM. As demand increases, we can move to a larger Dell server with 4 processors or to a large Unix server from SUN. If a small organization is interested in adopting the server, a small PC running Windows or Linux that costs less than \$ 1,000 can be used. In short, the system is scalable from the lowest possible configuration of less than a 1K PC to a mainframe.

Cost-Effectiveness: XML and Java are available without cost.

Applicant's qualifications

The University of Pittsburgh School of Health and Rehabilitation Sciences is a leader in the field of rehabilitation and assistive technologies for people with disabilities. The School has excellent resources that are important to this project, including state-of-the-art computing labs as well as a wide range of assistive technology applications. Pittsburgh Vision Services has extensive resources for training of visually impaired users and also strong assistive technology support services. The other project partner, the American Foundation for the Blind, founded by Helen Keller, is a leading national organization dedicated to addressing critical issues that face the 10 million Americans who are blind or visually impaired.

The key personnel in this project have formal training and extensive experience in information technology, assistive devices, end-user training and support, accessibility for blind users, and disability studies. Dr. Bambang Parmanto has a PhD in computer and information sciences with extensive experience in information technology development. Dr. Miriam Hertz has extensive training and experience with needs of, services for, and research concerning people with disabilities, and has extensive contacts in the disability community. Mr. Spero Pipakis is a blind professional who has worked with assisting blind people to use computers and the Internet for the last 10 years. Mr. Scott Duncan is visually-impaired individual with an MA in rehabilitation teaching. He has been in the vision loss field for 17 years within both the not-for-profit and technology manufacturing sectors (see Key Personnel Qualifications in Appendix V).

Budget

The University of Pittsburgh will be responsible for all financial and administrative aspects of the project. The University has extensive skills and experience in managing federal grants. The project budget includes funding for equipment; staff and faculty time, and research assistants for deployment and maintenance of the gateway; staff time for end user support (about 10% allocation); travel to conferences for project dissemination; and supplies and software for development and deployment of the gateway (see Budget Narrative). A significant portion of the budget (more than 10%) will be allocated for the project's evaluation component.

Implementation

The project timeline (see Appendix IV) identifies major tasks and the schedule for their completion. In Year 1, the accessibility gateway will be fully developed and tested. Participants who will be using and evaluating the system will be recruited towards the end of Year 1. In Year 2, usability testing and gateway refinement will be performed and the results will be analyzed, published, and disseminated. In Year 3, the refined gateway will be deployed and a summative

evaluation will be conducted. This three-year timetable will be used to evaluate the progress of the project, together with a more detailed timeline developed for each major task.

Privacy

For the purposes of evaluation and research on the accessibility and effectiveness of the gateway approach, a protocol on human subject protection will be submitted to the University of Pittsburgh's Institutional Review Board (IRB). Research will be conducted only in compliance with the University's stringent IRB guidelines. The complete anonymity of individuals using the gateway who are not directly connected with the project will be respected. From this outside user population, we will collect only general information, such as their number and their choice of assistive device and browser. We will not collect personal information about users without their consent.

Sustainability

The University of Pittsburgh and the American Foundation for the Blind are committed to sustaining the gateway beyond the duration of the project. Once a gateway system has been developed, the cost of maintaining it is expected to be relatively low. Our project efforts will include working to win the interest of ISP and portal sites in providing the gateway service. It is anticipated that the cost of the server would be offset through advertising revenue and a gain in new ISP subscribers.

5 Community Involvement

Partnerships

Effective partnerships are critical to the implementation and viability of the gateway project. The partner organizations have been chosen based on their capacity to represent the interests of target groups, including consumers and professional groups, and/or to provide instructional and technical support to users. Following are the partner organizations and their roles:

- Pittsburgh Vision Services (PVS) is a local organization that provides assistance to visually-impaired individuals. PVS provides rehabilitation services, vocational programs, community and support services, community education programs, and employment opportunities. In this project, the PVS Access Technology Center will provide end-user training and supports (see Appendix VI for letter of support)
- The American Foundation for the Blind (AFB) is a national organization dedicated to addressing the critical issues of literacy, independent living, employment, and access through technology for people who are blind or visually impaired. AFB will assume three roles in this project: evaluation, dissemination (including user recruitments from all over the country), and providing feedback during the development of the gateway (letter of support Appendix VI).

Obtaining and sustaining community involvement

Community involvement will be conducted in two primary ways. First, the community will participate in the project development and evaluation components through expert input and in the usability studies. Second, the community will participate in a final summative evaluation utilizing focus groups. Finally, the utilization-focused model [13] will be used to formatively evaluate and improve technology development and project activities for all three years. The utilization-focused model relies on the continual assessment of a project's effectiveness from the perspective of community stakeholders. The emphasis in this approach is to involve the stakeholder groups in monitoring, evaluation, feedback, and improvement throughout the life of

a project. In this project, representatives selected from key stakeholder groups will be involved in all aspects of planning and development, including the design and implementation of the evaluation process. This entails that staff responsible for program implementation have an obligation to insure the effective representation of key stakeholders and to remain responsive to their priorities and concerns. The key stakeholder groups in this project are identified as 1) persons who are visually impaired, 2) disability service organization personnel, most notably from PVS and AFB, and 3) communications and computer professionals. This utilization-focused evaluation process will involve the participation of representatives of these groups at different stages of the project. Any problems with, for example, subject recruitment or technical difficulties, will be addressed and resolved through this process. Dr. Miriam Hertz will dedicate her project time (0.3 FTE) to coordinating partnerships and community involvement.

Support for end users

There will be two types of users of this gateway, with differing needs for training and support. The first group will be comprised of visually impaired users who already have been using computers, likely utilizing assistive technologies. This group of users will be recruited from all over the country by AFB and via user's groups on the Internet and other mailing lists. The second group will be visually impaired users who are new to the Internet and are not familiar with computers. The more experienced users will be able to use the gateway service with little or no training. User support will be provided in the form of a help-desk that will accept questions and complaints via email and telephone. PVS will dedicate approximately 40 hours of staff time per month for end-user support. About 10% of the project's budget is dedicated for end-user support.

6 Evaluation

Evaluation Questions

The primary goal of the evaluation process is to determine if the expected outcomes as stated in the Project Purpose have been achieved. The first three goals will be evaluated through a controlled study of approximately 50 users with visual impairment. From our previous research, we know that this sample size is statistically sufficient for this type of study. User subjects will be randomly divided into two groups, a control group comprised of 25 users accessing the Internet without the gateway and a test group composed of the other 25 users accessing the Internet utilizing the gateway. Usability studies will be used to answer the following questions:

- Does the accessibility of Internet websites increase if the gateway is used?
- Does the productivity for visually impaired users who utilize the gateway increase?
- Does the user satisfaction of visually impaired users increase if the gateway is used?

The summative evaluation will address the following question:

- What kinds of services are needed to support visually impaired users in utilizing the gateway?

Evaluation Strategy

The usability evaluation for achieving the first three goals will be achieved through testing the following hypotheses:

- Hypothesis 1: The accessibility of the Internet for visually-impaired users will significantly increase with use of the accessible gateway.

- Hypothesis 2: The productivity of visually-impaired users will significantly increase with use of the accessible gateway.
- Hypothesis 3: The user satisfaction of visually-impaired persons will significantly increase with use of the accessible gateway.

The dependent variables will be accessibility test scores (using the objective Bobby Accessibility test and subjective Accessibility Questionnaires) to evaluate hypothesis 1, productivity scores to evaluate hypothesis 2, and user satisfaction scores to evaluate hypothesis 3. To test the productivity of the users, the two groups in this study will be asked to open several target websites and then perform a set of usability tasks. To test hypothesis 3, both groups will be asked to complete a User Satisfaction Questionnaire (see Appendix III). The scores of the two groups on the three measures of productivity, accessibility, and user satisfaction will be compared, and a statistical analysis will be performed. The statistical analysis will show whether the target outcomes of the project have been met.

	Group of visually impaired users	
Access approach	No gateway	Gateway
Usability test results	Score ₁	Score ₂

Table 2. Design for testing Hypotheses.

A summative evaluation will be performed on the tasks related to the fourth goal. The hypothesis for the fourth goal is: A model for effective delivery of the gateway can be developed. To test this hypothesis, participants from the test group of 25 individuals who utilized the gateway will be invited to form focus groups, wherein they will assist the investigators in developing an open-ended survey that will be disseminated to all who use the gateway. The questions to be addressed will include perceptions of services needed and rendered and the project's effectiveness, such as the long-term consequences of the gateway.

Data Collection

A Likert scale of five items will be utilized for each of the usability questionnaires (See Appendix III). For the performance section of the usability tests, data collected from each task will include time elapsed, number of clicks (steps) utilized, and task final success/failure. The results will entail composite scores for each of the 50 participants in both groups on three different measurements: accessibility, user satisfaction, and productivity. For the summative evaluation, data collection will include perception of training and types of support needed for the users, etc.

Data Analysis

Statistical analysis will be conducted to test the three hypotheses of technology evaluation (the first three goals). For each hypothesis, a straightforward two-sample *t* test will be used. An alpha level of 0.05 and a beta of 0.20 [14] will be utilized for testing all hypotheses.

Evaluator

In our commitment to ensure that the gateway achieves its goals, \$77,790 in direct cost (more than 10%) has been budgeted for rigorous usability studies to be conducted independently by AFB. The results of the evaluation not only will improve the gateway, but will be important information for the information technology and accessibility communities.